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Institute for Manufacturing and Sustainment Technologies

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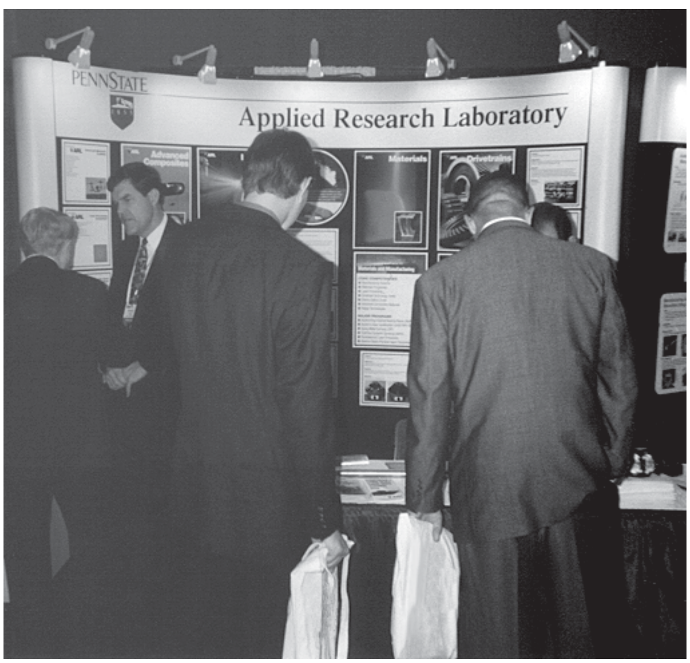
A U.S. Navy Manufacturing Technology Center of Excellence

QUARTERLY

2004 No.4

DMC 2004 Concludes Navy ManTech's Calendar Year Activities

Members of iMAST recently participated in the annual Defense Manufacturing Conference, held in Las Vegas, Nevada. Once again, leaders from government, industry, and academia assembled to exchange perspectives and information relative to manufacturing technology, industrial modernization, and related DoD transformational initiatives. This year's theme "Advancing the Industrial Base to Support the Warfighter" set the stage for forum discussions concerning the defense industrial base and its impact on sustaining the U.S. warfighter, who is currently engaged in full-scale combat in Southwest Asia.



Defense Manufacturing Conference 2004 was hosted by the Joint Defense Manufacturing Technology Panel (JDMTP), which identifies and integrates requirements, conducts joint program planning, develops joint strategies, and oversees the execution of manufacturing technology and sustainment programs conducted by the Army, Navy, Air Force, and the Defense Logistics Agency.

The conference featured senior guest speakers from the Department of Defense and industry, as well as various flag officers from the military services. Keynote speakers included the Honorable Albert Frink, Assistant Secretary of Commerce for Manufacturing and Services, and Ms. Sue Payton, Deputy Under Secretary of Defense for Advanced Systems and Concepts. Mr. Elmer Doty, Vice President and General Manager of United Defense (L.P. Ground Systems Division) represented industry. Congressman Donald Manzullo (R-Illinois), gave an enthusiastic talk entitled "Congressional Perspective on the Importance of Manufacturing to the United States."

ARL's Donald Heaney gave a presentation on metal injection molding of warheads. Metal injection molding (MIM) is a net-shape binder-assisted forming technique that lowers manufacturing costs while providing higher material groove detail which allows optimum fracture behavior in warheads. Metal injection molding techniques can be used for steel, stainless steel, titanium, and refractory metals, as well as tungsten heavy alloys.

Next year's annual conference will be held in Orlando, Florida from 28 November through 2 December. The event will be hosted by the U.S. Navy Manufacturing Technology Program Office, Office of Naval Research. For more information about this event, check future issues of the iMAST newsletter, or contact our institute administrator, Greg Johnson, at (814) 865-8207 or <gjj1@psu.edu>.

Focus On Manufacturing Systems

Report Documentation Page

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IN THIS QUARTERLY

DIRECTOR'S CORNER: NEW CHALLENGES

Happy New Year! As we end the 2004 calendar year, we have much for which we can be thankful. Looking at 2005, we have many challenges we will be turning our attention to. With the new year we also have some new changes. We congratulate our previous program manager, John Carney, who was recently selected for promotion to acting director of the Navy' s Manufacturing Technology Program. He takes over from Adrienne Gould, who was promoted to deputy, Industrial and Corporate Programs

and acting director, Product Innovation Division. Congratulations to Ms. Gould and Mr. Carney. I thank you both for all the hard work, sacrifice, and dedication you provided iMAST and the other centers of excellence. We now welcome aboard Greg Woods, who has assumed the responsibility of program manager for iMAST. Mr. Woods is no stranger to us as he also serves as program manager for our Repair Technology program.

During the year, iMAST shifted the focus of its programs to the CVN 21—the next generation aircraft carrier. As such, we teamed with other Centers of Excellence, Northrop Grumman Newport News, and PEO Carriers, as well as the Naval Surface Warfare Center, to develop solutions to manufacturing issues associated with the new design. As this carrier design may last into the 22nd century, the impact of technology advances will be felt for a long time. The savings we hope to achieve in total ownership costs will hopefully be significant. We are working hard to ensure a positive teaming attitude as a main focus.

We have just returned from the Defense Manufacturing Conference. I was impressed by the quality of the technical sessions. A lot of excellent work is being produced by the Manufacturing Technology program. This conference also included several presentations from representatives of the Department of Commerce. The department's focus on improving manufacturing dovetails well with the goals of the Manufacturing Technology Program. Working together should benefit manufacturing in the United States.

Our feature article addresses a ManTech project aimed at optimizing the use of a new covered modular outfitting facility at Northrop Grumman Newport News. Through the use of discrete event simulation models, operators will be able to better plan production, resulting in lower costs. This project uses powerful tools produced by Delmia©.

As we start the new year, we'll be initiating planning for FY06 projects. The next platform iMAST will be focusing on is the Littoral Combat Ship (LCS). With its rapid acquisition strategy and challenging requirements, there is probably no lack of manufacturing issues. If you have a challenge for which you need a solution, or you have a solution to an existing challenge that we can assist you in finishing development, please give us a call.

In closing, I would like to thank all of you for your continued support of our Navy Manufacturing Technology Program at ARL Penn State. I wish you a happy and safe holiday season. As 2005 approaches, I hope you will put visiting us and our facilities down as one of your New Year's resolutions, especially if you have not been here before.

Bob Cook

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Focus on Manufacturing Systems

Simulation-Based System Analysis and Resource Allocation

by Daniel A. Finke and Christopher B. Ligetti

INTRODUCTION

In support of the next generation aircraft carrier, the CVN 21 class, Northrop Grumman Newport News (NGNN) has developed a long term strategic plan to modernize their shipyard. In this plan, several new facility construction projects have been proposed that will increase the level of complex outfitting and assembly that typically occurs throughout the ship construction cycle. These new facilities provide controlled environments that will enable schedule and cost improvements for work that traditionally was performed outdoors. One facility in the strategic plan is a new Covered Modular Outfitting Facility (CMOF). The CMOF will be a covered, temperature-controlled facility located under the large gantry dock crane which will be used primarily to assemble high-value-added products. NGNN believes that new facilities similar to the CMOF will increase productivity in several ways: decrease lost work days due to weather, reduce rework due to damage, and increase the efficiency of the workspace and workforce.

Even though the strategic planning phase for these new facilities has been completed, several details need to be finalized to determine the maximum benefit that can be realized from each. To accomplish this, ARL Penn State engineers have utilized simulation modeling to verify that higher levels of productivity are consistent with a new covered facility than the current uncovered (tarps and Quonset huts) production operations. The simulation models have also been used to help plan the allocation of space and utilization of other critical resources such as cranes, and personnel associated with the construction of complex ship modules planned for the CMOF.

Artist's rendering of CVN 21 class of aircraft carrier © U.S. Navy

BACKGROUND

Shipyards have traditionally used a build strategy that utilizes linear build sequences, producing larger and larger subassemblies (units) as they progress along the production line. In this strategy, raw material, steel plates and shapes, are cut and joined together to form panels. These panels are then joined together to form larger subassemblies, (e.g., decks or bulkheads). The larger subassemblies are then joined together to form large

PROFILES

Daniel A. Finke is an assistant research engineer at Penn State's Applied Research Laboratory. Mr. Finke holds an M.S. in industrial engineering and operations research from Penn State, as well as a B.S. degree in industrial engineering from New Mexico State University (with minors in management and mathematics). Prior to joining ARL, Mr. Finke was a co-op student with General Electric Aircraft Engines and Ethicon Endo-surgery. His current research interests include simulation-based optimization and scheduling, resource allocation optimization and decision support. Mr. Finke is currently working on new construction shipyards to improve production performance and provide decision support for new acquisitions. He can be reached at (814) 865-5178 or by email at <daf903@psu.edu>.

Christopher B. Ligetti is an assistant research engineer in the Manufacturing Systems department at Penn State's Applied Research Laboratory. While with ARL, Mr. Ligetti has contributed to manufacturing systems simulation and modeling projects for Northrop Grumman Newport News and General Dynamics Electric Boat. Mr. Ligetti joined ARL following completion of an M.S. degree in industrial engineering and operations research. He also holds a B.S. degree in industrial and manufacturing engineering from The Pennsylvania State University. Mr. Ligetti's previous research activities include multi-objective optimization in engineering design and metamodeling. While a student at Penn State, Mr. Ligetti completed internships with Arthur Andersen, LLP in Cleveland, OH and McConway & Torley Corp. in Pittsburgh, PA. He can be reached by calling (814) 865-7619, or by email at <cligetti@psu.edu>.

subassemblies known as blocks or superlifts. These superlifts form the building blocks that ultimately become the ship.

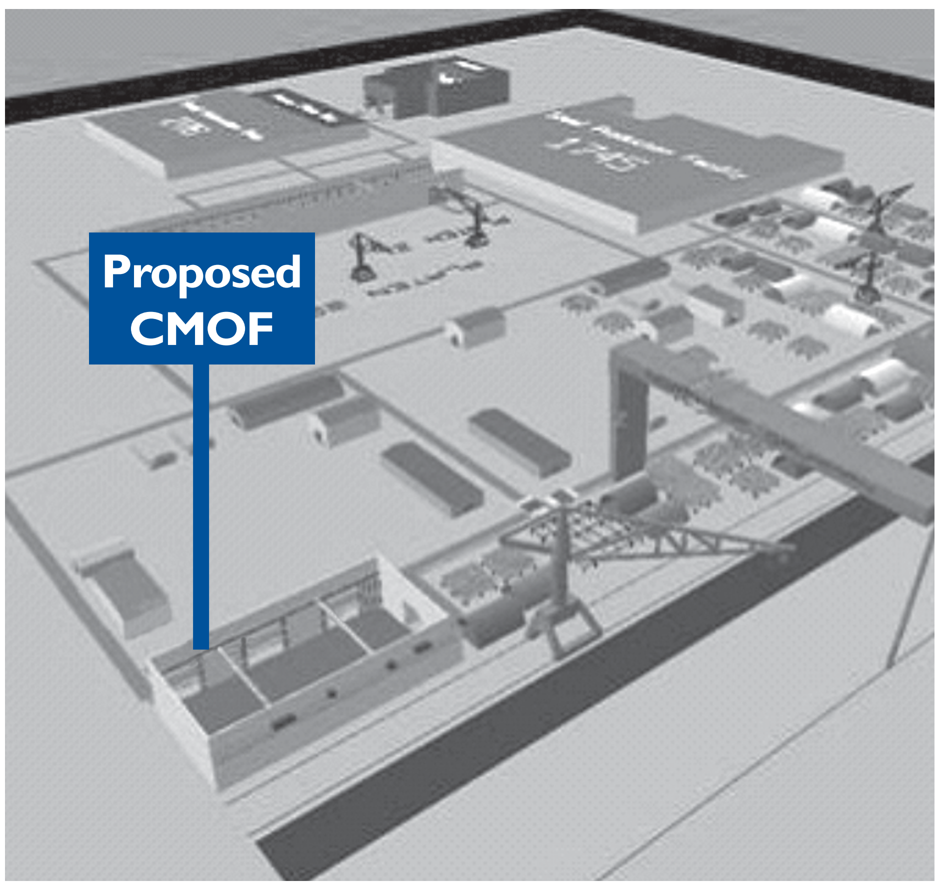
At NGNN, the large subassemblies and superlifts are constructed and outfitted on platens and are screened from the environment by temporary shelters and tarps. These shelters and tarps provide minimal protection against inclement weather. As a result, up to 60 days of production per year are impacted to some degree by lower efficiency or lost altogether due to weather. In addition, valuable production time is consumed setting up the temporary shelters and tearing them down when production is complete. In an effort to reduce or eliminate these production days lost due to weather and time spent to setup and tear down temporary shelters, NGNN has invested in a new facility (CMOF) that will be an all-weather, year-round shield against the environment. The CMOF will be a climate controlled facility that will provide cover for about 20% of the Final Assembly Platen, the construction area that is spanned by the large dry dock crane.

The CMOF will be primarily used for structural construction and outfitting for high-value-added products critical to the initial erection sequence of the nuclear powered vessels that NGNN builds. Protecting these products from the environment is critical to their integrity and condition since many are sensitive and expensive components. Such protection eliminates the need for rework due to water intrusion and damage.

OBJECTIVE

ARL Penn State has identified three objectives for this effort: (1) provide analytical proof that the new building will provide the expected productivity improvements, (2) optimize the operations in the new facility, and (3) provide independent case-use for assembly simulation modeling tools. NGNN has conducted a high level analysis supporting the construction of

North Yard at Northrop Grumman Newport News



Simulation model of North Yard with proposed CMOF (note: roof not shown)

the CMOF; however, the timing of the construction has been altered from the original plan. The actual timing for the construction of this facility has presented another issue, in that, the ship production schedule for certain critical assemblies begins before the CMOF planned completion date. This somewhat negates the benefit of the facility in the construction of these intensely outfitted items. The ARL Penn State simulation analysis details the benefits and trade-offs of three configurations; (1) construction in existing facilities (2) construction in CMOF on planned schedule, and (3) construction in CMOF on altered construction schedule.

Several build strategies and space utilization algorithms will be tested in an attempt to determine the best construction scenario for the current configuration, in which the CMOF construction schedule is delayed. Because the facility is delayed, several less desirable build locations will be available for the various process steps required to build the products. A comparative study of these options is necessary to determine the operational configuration that minimizes the span time of the products constructed or outfitted in the CMOF.

The third objective called for ARL Penn State to demonstrate the capabilities, benefits, and drawbacks of one commercial, off-the-shelf assembly simulation modeling tool. Investing in this software would require NGNN to make a major investment in time, money and resources. Because of this, NGNN would like to be certain that the investment would give a satisfactory return.

METHODOLOGY

Two methods and tools were used to accomplish the objectives outlined in the previous section. These methods include a discrete event simulation (DES) model and an assembly simulation model. The DES model was used as the analytical tool for justifying the construction timing and operation optimization for the CMOF. The assembly simulation model was used as a verification tool as well as a pilot to independently demonstrate the capabilities of the tool.

The DES model was built in the Quest© simulation software and the Assembly Simulation model was built using Digital Process for Manufacturing (DPM), both products of Delmia©.

DISCRETE EVENT SIMULATION

Discrete event simulation modeling is a proven tool for providing answers to operational questions. Knowing this, discrete event simulation models were built using construction sequences developed in the planning phase of the high-value-added products. These simulation models were used to accomplish the first two objectives.

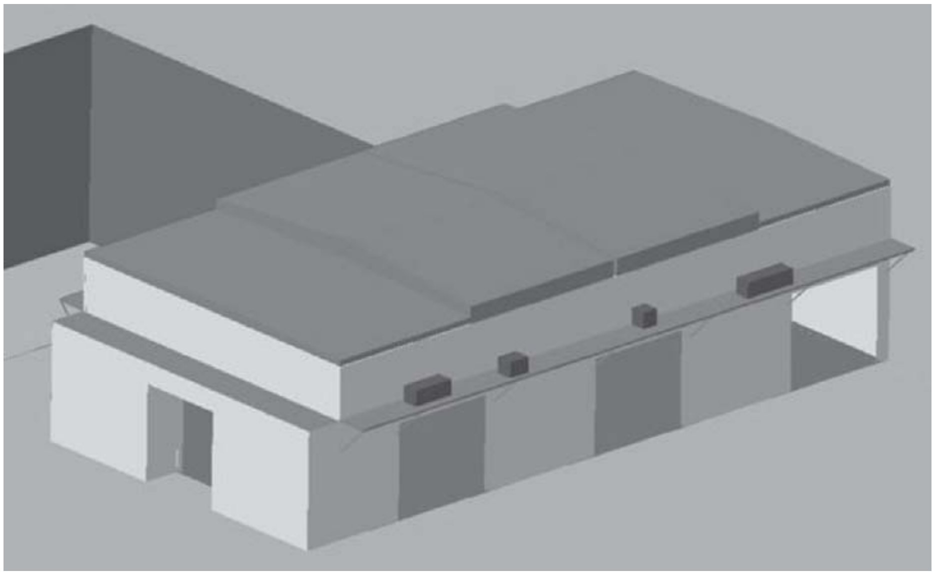
The foundation of the DES simulation models developed by ARL Penn State was built from information gathered from interviews conducted with personnel from NGNN. In these interviews, the ARL Penn State project team walked through the process of building the assemblies, gathering processes steps, process times, resource requirements, and detailed build strategies. Through several of these interviews, and iteration of a "first-cut" model, a detailed simulation model was constructed and validated that reflected the actual production environment and current manufacturing operations to an agreed upon level of detail. A second DES model was developed, representing the proposed shipyard activities, particularly, the availability of the CMOF for the construction of several high-value-added bulkheads. The two DES models were then used to further demonstrate the benefits of the CMOF through a comparative study.

The DES model with the proposed CMOF and altered construction schedule was then used as the baseline and several operational questions were asked of it. This model was built with various flexible options to assist NGNN in evaluating multiple manufacturing strategies including resource limitations (e.g., fixtures and tooling), work location (e.g., in the CMOF or other shipyard facility), and outfitting orientation (e.g., horizontal versus vertical). As candidate build strategies continued to arise, the DES model was used to perform comparative studies to optimize the CMOF operations and to identify the most cost effective methods of building high-value-added assemblies. These efforts were facilitated through the creation of Assembly Simulation models of the modeled products, which provided detailed visualization of varying assembly sequences.

The DES model with the proposed CMOF and altered construction schedule supports the capacity analysis phase of the project as well. The simulation model was used to evaluate production alternatives in relation to schedule and space. As additional assemblies are proposed for construction in the CMOF, the DES model will continue to be used to support the acceptance or rejection of these assemblies inside the CMOF.

ASSEMBLY SIMULATION

The purpose of the Assembly Modeling phase was for ARL Penn State to independently demonstrate the capabilities of the assembly modeling software and to provide a validation of the assembly sequence for NGNN. To accomplish this, one high-value-added bulkhead was chosen as the test case. Geometry was obtained from the CAD system and imported into the software. From there we used the tool to create an assembly sequence. In this sequence, geometry was moved along a path similar to the path that would be used during construction. The sequence was then presented to NGNN for validation. The final sequence helped provide another level of validation for the DES model. Another purpose of the Assembly Simulation model was discovered during the validation. This purpose was to view components with difficult installation procedures in more detail. Several piping assemblies are very complex and difficult to install. This tool provides a planner the ability to move the assembly to obtain the best installation strategy. It also allows the planner to create alternative



Detailed rendering of Covered Modular Outfitting Facility

subassemblies to facilitate an easier installation.

It is expected that more detailed assembly models will be generated to help planners and construction personnel develop an “optimal” construction sequence. Also, other ship construction products planned for this specific facility will be modeled to further demonstrate the capabilities of this tool.

RESULTS

Initial modeling efforts conducted by ARL Penn State for a series of CVN 21 high-value-added bulkheads constructed in the proposed CMOF resulted in a 15-day lead time reduction. These results assume the availability of the CMOF for the entire construction period of these units. However, based on current construction plans for the CMOF, the facility will not be available for the initial bulkheads in the first in class CVN 21 carrier. Therefore, the construction of these units must begin in other locations throughout the shipyard that will be subjected to inclement weather conditions and limited access to the large cranes required throughout the construction process. This comparative analysis suggests that the construction of the CMOF should be moved forward to benefit from its use.

The DES model of the CMOF was also used by ARL Penn State to provide information which would help NGNN refine their current planning schedules for the candidate assemblies constructed in this facility. Initial results indicate that other assemblies, in addition to the high-value-added bulkheads, can also be constructed in the CMOF, but only through careful planning of the release and space allocation of all candidate units.

The Assembly Simulation model of one high-value-added bulkhead outfitting process is currently being used in an attempt to identify the assembly sequence that would minimize the outfitting process time. Possible opportunities for lead time reduction include reorientation of the bulkhead during the outfitting process and parallelization in installing multiple pipe assemblies. The Assembly modeling tool has proven to be beneficial, however, a quantitative value has yet to be established.

CONCLUSIONS

Results obtained from the DES model of the CMOF suggest that its construction should commence earlier than planned. The use of the CMOF for the construction of several high-value assemblies will result in a lead time reduction compared to current build methods, and process duration variability will be subsequently minimized due to the environmentally protected facility. This illustrates one of the primary benefits of simulation: system comparison of current operations to proposed operations. Although simulation is an abstraction from the actual environment, it still provides valuable information and insight into systems that could not be anticipated otherwise. NGNN can refine their planning schedules using this “look-ahead” capability in an effort to optimize the usage of their production facilities. The DES simulation model, as well as the assembly simulation model, will continue to be used by ARL Penn State, in conjunction with NGNN, to answer various questions regarding the construction of several assemblies (e.g., high-value-added bulkheads). Particularly, the DES model will be used to evaluate the impact of various manufacturing strategies and the inclusion of additional assemblies to be built in the CMOF. The assembly simulation models will aid NGNN in identifying the final assembly sequences for several complex operations. Simulation modeling techniques, both Discrete Event and Assembly, allow stakeholders to better understand products, processes, and operational constraints to develop the most feasible production plan, and to conceptualize the production environment. From this, simulation can decrease overall cost and lead times through detailed visualization and analysis.

Acknowledgement

The authors wish to express appreciation for support of this effort by the Office of Naval Research Navy ManTech Program Office and the Institute for Manufacturing and Sustainment Technologies (iMAST), a U.S. Navy ManTech Center of Excellence. Any opinions, findings, conclusions and recommendations expressed in this article are those of the authors and do not necessarily reflect the views of the U.S. Navy.

New Navy ManTech Program Director

Mr. John Carney, the current iMAST Navy program manager, has been selected to head the U.S. Navy Manufacturing Technology Office at the Office of Naval Research. As director of Navy ManTech, Mr. Carney will be responsible for managing the ManTech Program, which includes the Navy's nine Centers of Excellence. Mr. Carney is tasked with developing, coordinating, and integrating program policies, procedures, and content throughout the U.S. Navy. He will work in cooperation with the joint services and applicable agencies. He is also the Navy's representative to the Joint Directors of Laboratories Manufacturing Science and Technology Panel. A native of Sterling, Virginia, Mr. Carney holds B.S. and M.S. degrees from Virginia Tech in industrial engineering. Mr. Carney can be reached (703) 696-0352, or by e-mail at <carneyj@onr.navy.mil>.

New iMAST Navy Program Manager

Mr. Greg Woods has been designated as iMAST's new program manager for the Navy ManTech Program effort ongoing at ARL Penn State. No stranger to ARL, Mr. Woods has been serving as program manager for iMAST's Repair Technology program.

Mr. Woods succeeds Mr. John Carney who has been appointed acting-director of the ONR's Navy ManTech Program. As iMAST program manager, Mr. Woods will provide financial and programmatic oversight to iMAST, as directed by the Office of Naval Research. A mechanical engineer, Mr. Woods holds a bachelor of science degree from Tennessee State University, as well as an EMSE graduate certificate from George Washington University. A native of Memphis, Mr. Woods has over 20 years experience in surface ship structural integrity as well as materials design and application with NAVSEA and NSWC-Carderock Division.

Mr. Woods can be contacted by calling (703) 696-4788, or by e-mail at <woodsg@onr.navy.mil>. We are pleased to have Mr. Woods as part of the ARL Penn State-Navy ManTech team.

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CALENDAR OF EVENTS

11–14 Jan.	Surface Navy Association Symposium	★★★★★★★ *visit the ARL booth*	Crystal City, VA
1–2 Feb.	NCEMT Ship and Ground Advanced Materials Conference		Orlando, FL
1–2 Mar.	ShipTech 2005	★★★★★★★ *visit the iMAST booth*	Biloxi, MS
22–24 Mar.	Navy League Sea-Air-Space Expo	★★★★★★★ *visit the ARL booth*	Washington, D.C.
19–21 Apr.	NDIA Science and Engineering Technology Conference DoD Tech Exposition		Charleston, SC
2–4 May	Navy Opportunity Forum		Reston, VA
May TBA	ARL Materials and Manufacturing Advisory Board (Aerospace focus)		State College, PA
1–3 Jun.	American Helicopter Society Forum 61	★★★★★★★ *visit the iMAST booth*	Grapevine, TX
2–3 Jun.	Johnstown Showcase for Commerce	★★★★★★★ *visit the iMAST booth*	Johnstown, PA
Aug. TBA	TechTrends 2005	★★★★★★★ *visit the ARL booth*	TBA
Aug. TBA	ONR Naval-Industry R&D Partnership Conference	★★★★★★★ *visit the iMAST booth*	Washington, D.C.
Aug. TBA	ARMTech 2005	★★★★★★★ *visit the iMAST booth*	Kittanning, PA
Sep. TBA	Combat Vehicle Conference		Ft. Knox, NY
13–15 Sep.	Marine Corps League Expo	★★★★★★★ *visit the iMAST booth*	Quantico, VA
Oct. TBA	Expeditionary Warfare Conference		Panama City, FL
Oct. TBA	DoD Maintenance Conference		TBA
Oct. TBA	AUSA Expo		Washington, D.C.
16–19 Oct.	AGMA Gear Expo 2005		Detroit, MI
Nov. 28–1 Dec.	Defense Manufacturing Conference	★★★★★★★ *visit the iMAST booth*	Orlando, FL

Quotable

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